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The Question of Future Droughts in a CO₂-Warmed World

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Increased droughts are to be expected in a warmer world, and so are increased floods. A warmer atmosphere can hold more moisture, and evaporate more water from the surface. Thus, when it is not raining, available soil water should be reduced. When it is raining, it could very well rain harder. Most researchers agree then that a warmer world will have greater hydrologic extremes. In addition, there is a basic imbalance that develops as climate warms, between the loss of moisture from the soil by evaporation and replenishment via precipitation. The land has a smaller heat capacity than the ocean, so it should warm faster. Evaporation from the land proceeds at the rate of its warming, while precipitation derives primarily from evaporation at the ocean surface. As the latter is increasing more slowly, in a warmer world, precipitation will not increase as rapidly as evaporation due to the fact that the oceans warm more slowly than the land surface (evaporation over the ocean is slower than over the land). Hence, more droughts are anticipated in a warmer world, but the specific location of such droughts is somewhat uncertain.

To address the question of where droughts are likely to occur, one first needs to have a reasonable sense of what the future magnitude of warming will be, and what the latitudinal distribution of warming will be. For example, the greater the warming at high latitudes relative to low latitudes, the more likely there will be increased drought over the U.S. in summer. In contrast, substantial tropical warming could give us El Nino-like precipitation, with intensified flooding along the southern tier of the U.S. All of these conditions are likely to intensify as the global temperature rises.

Output from General Circulation Models (GCMs) has been used in an attempt to be more specific. Utilizing soil moisture output from the GCMs, the IPCC (Intergovernmental Panel on Climate Change) Working Group I (The Science of Climate Change) has focused on the moderate probability that summertime droughts will afflict middle

latitudes (i.e., developed countries). IPCC Working Group II (Assessment of the Possible Impacts of Climate Change) using the temperature and precipitation output from GCMs has focused on the vegetative stress that GCMs project will occur at low and subtropical latitudes (hence, for developing countries). Clearly, available water (in the form of soil moisture) and the health of vegetation (productivity) are two related but somewhat different aspects of drought, for which an integrated assessment of their combined effects will likely give a more thorough picture of future drought possibilities.

What, therefore, can be concluded about the likelihood of future drought in any particular area? Each of the IPCC projections (GCM and Assessment model output) appears to have a scientific basis for suggesting that developed and developing countries might be strongly affected. Least likely to suffer drought are high latitudes, where flooding would seem to be a more likely problem. Modeling improvements in both GCMs and Impact Assessment models are required before scientists can estimate more precisely where the effects of floods and droughts are likely to be most severe. In any case, because hydrological extremes should increase in a warmer world, being prepared for such events would seem to be a prudent strategy.